Space Weather Technical Forecast

Issued on Sunday, 14 May 2023 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1/R2 radio blackouts, decreasing slightly into new week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with X-ray activity recorded at GOES16 confined to occasional C-class flares. These peaked with an impulsive C7.0 flare observed at 14/0917UTC, originating from AR3296 close to the northwestern limb. An SDO data outage covered much of the period from 13/0130UTC, rendering sunspot analysis more difficult, and as a result observed sunspot trends are necessarily very general for the period. There are up to seven regions visible in available GONG Intensitygram imagery, with AR3296 presumed to remain in place just over the edge of the disc on the northwestern limb by inference from continuing C-class activity. No new major CMEs were observed in the period. At 13/2100UTC, a disappearing filament was observed in Big Bear H-Alpha imagery from the northeastern quadrant. Any Earth-directed component is unlikely from this location. A similar such event was then seen from the southeast on the same imagery at 14/2300UTC. The only other CME visible on coronagraphs a narrow west-heading feature that appears narrowly far sided to no effect at Earth.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, remained at slightly elevated levels around 450 km/s. An unexpected IMF enhancement occurred later in the UTC day of 13 May - possibly an SSBC. As part of this, the IMF changed from a very smooth and level trend at Weak levels near 5nT to linearly approach a peak at Moderate levels of 15nT at 13/2000UTC, before returning to previous Weak levels. The north-south component was consistently co-aligned with Earth's 15nT field with a peak of +6nT, with the notable exception of the UTC evening, which saw a sharp descent to a nadir of Moderate levels reaching -15nT before recovering back to Weak levels. The solar wind density was mostly within its typical background range, but peaked at 12ppcc at 13/1537UTC. The phi angle was mostly positive (away from the Sun). The net result of the above solar wind measures was mostly Quiet, with a provisional peak of Active Kp4 since the possible SSBC in the 18-21UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as measured at GOES16, remained at Background level through the period. High energy electron flux (greater than 2MeV), as measured at GOES16, ranged from Moderate to Normal Background levels, with a peak of 361pfu observed at 13/1615UTC. The 24-hour integrated fluence has been well below Active levels, with a near-level tendency. At 14/0001UTC, 6.8e6 integrated pfu was recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity carries a Chance of returning to Moderate, with this risk greatest over the current UTC weekend while AR3296 remains on the disc, else tentatively falling a little into the new working week, with no major returning regions expected.

Solar Wind / Geomagnetic Activity: The preferred forecast is for Quiet geomagnetic conditions through this four-day period. There are complicating factors: firstly in the form of up to three CMEs, namely the 11 May M2.1 southwest quadrant CME; the 12/0500UTC southwest filament CME; and the 13/0045UTC west limb CMEs that all have some form of glance in a minority of MOSWOC Enlil ensemble members on 14 through 16 May, however misses are all considered

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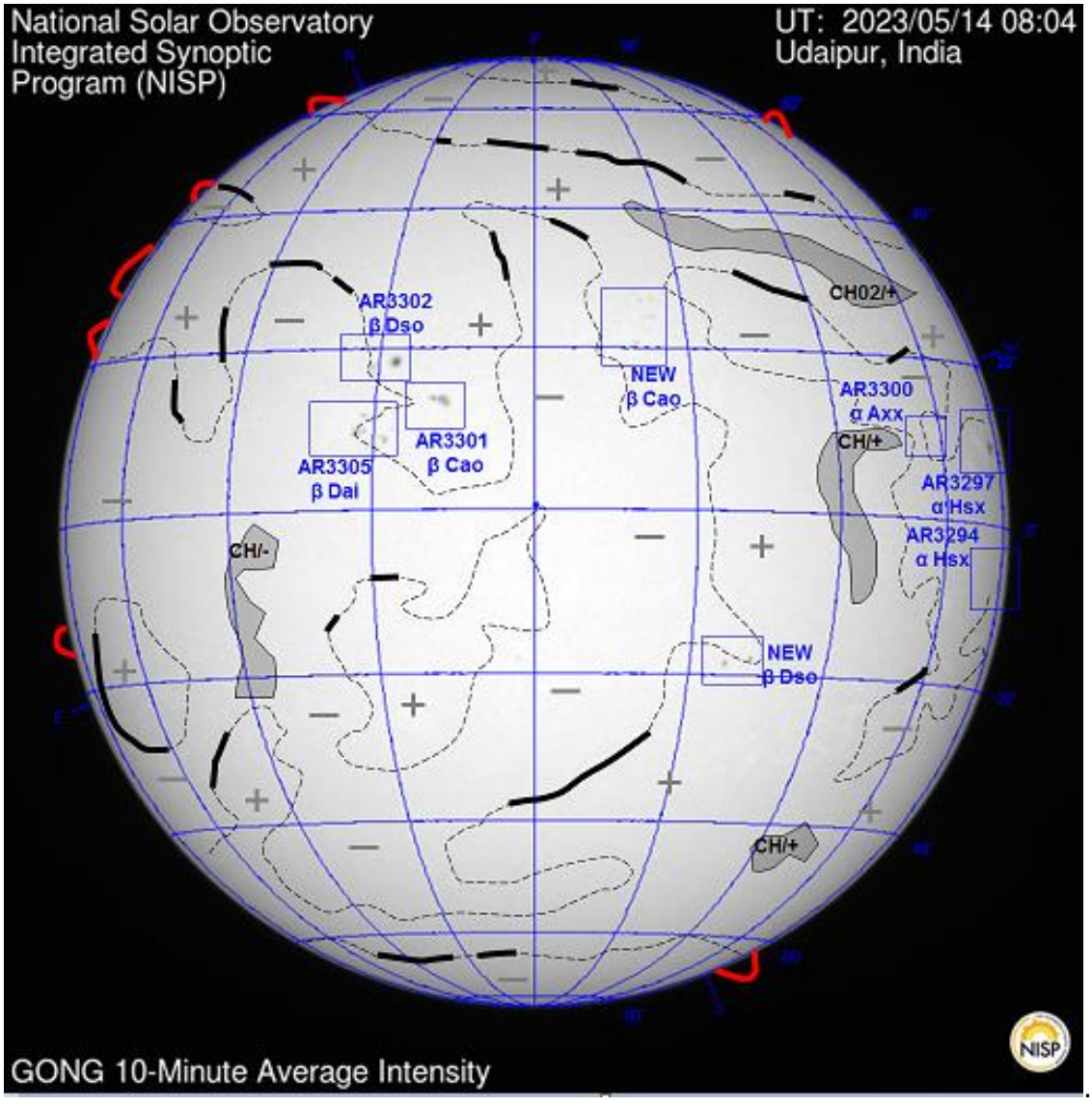
more likely to no effect. In addition to the above, there is a tenuous and unnumbered positive polarity coronal hole near the solar equator in the western solar hemisphere, with MOSWOC Enlil suggesting a 500km/s fast wind is possible, although this is not the preferred forecast, and should not cause significant activity.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux carries a daily Slight Chance of S1, decreasing slightly into the new working week as the main sunspot responsible for this risk crosses the limb and rotates away. High energy (greater than 2MeV) electron flux is expected to persist at Normal Background to Moderate levels. The associated 24-hour fluence is forecast to persist below the Active threshold.

Figure 1. Solar Analysis Valid 0800 UTC, 14 May 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

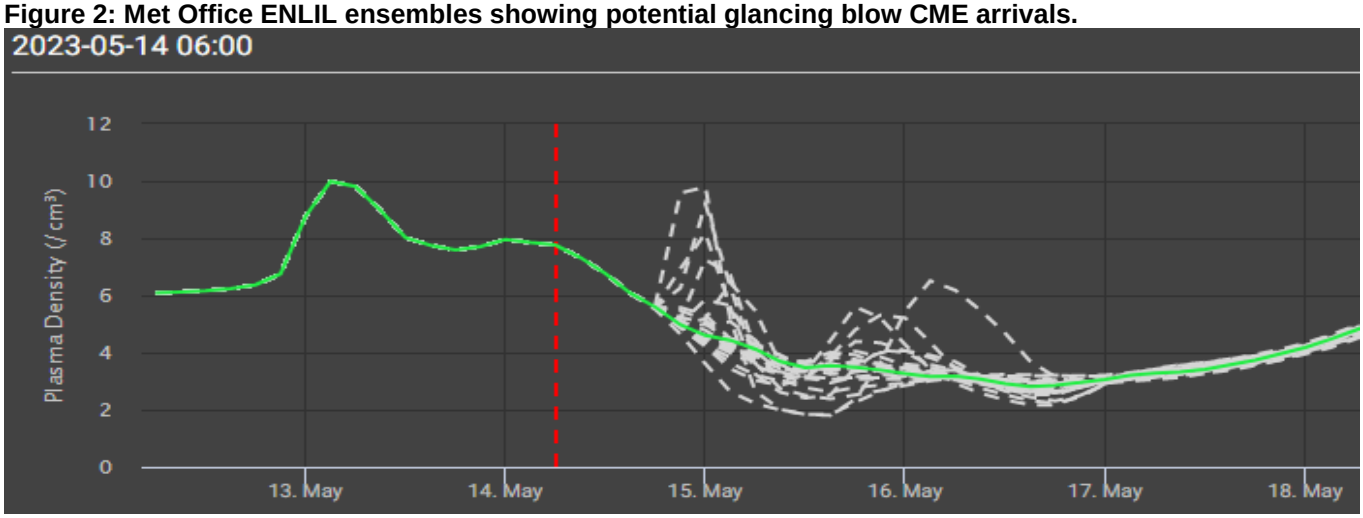
The geomagnetic headline for this period is for mainly Quiet activity. However there are complicating factors. Firstly, up to three CMEs feature as narrow glances in a minority of MOSWOC Enlil ensemble members. These are namely the 11 May M2.1 southwest quadrant CME; the 12/0500UTC southwest filament CME; and the 13/0045UTC west limb CME. These feature in succession until 16 May, however misses are all considered more likely to no effect at Earth, as shown in the main deterministic run. In addition to the transients, there is a tenuous and unnumbered positive polarity coronal hole near the solar equator in the western solar hemisphere, with MOSWOC Enlil suggesting a 500km/s fast wind, although this is not the preferred forecast, and should not cause significant activity. The persistence forecast is expected to show little impact from high latitude coronal hole 02, whose influence is assumed to pass above the ecliptic plane throughout the period. All considered, a Quiet geomagnetic forecast is Expected. There is a Slight Chance of G1 due to any potential impacts from each of the 11, 12 and 13 May CMEs, and perhaps also the unnumbered coronal hole through to and including 16 May, with Quiet conditions then more assured in the absence of any new activity by day four, Wednesday 17 May.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Most likely nil. See main text for low confidence glancing impacts

Figure 2: Met Office ENLIL ensembles showing potential glancing blow CME arrivals.



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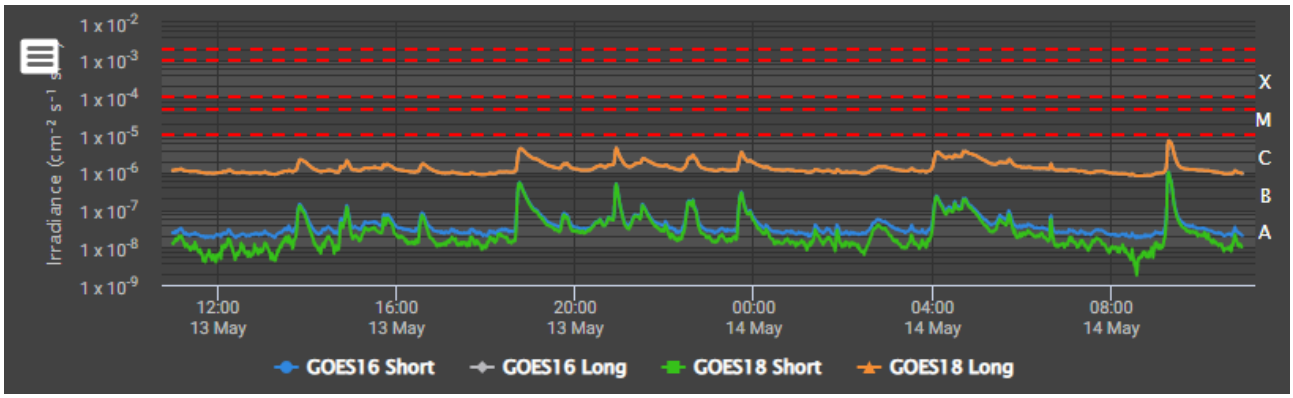
Radio Blackouts - X-Ray Flares:
There are seven sunspot regions that remain visible on NSO GONG Intensitygram imagery in the period, in the absence of the higher resolution SDO imagery. Discerning their Mt Wilson and Zurich classes is not possible to any degree of precision, and a persistence of their status as at 13/0130UTC is given, at least in the short-term and given the trends at that time (i.e. mostly slow decay). As stated, overall, the Sun seems to be entering an episodic lull in activity, with the Penticton 10.7cm flux falling from a midweek high of 180sfu on 09 May to reach 144sfu on 13 May. There appears to be little expected in terms of returning Carringtons for sunspot regions in the period, however a northeastern limb CME to end the last working week may hint at a region here, although it is at least a day away from the front side judging by its apparent absence from the latest available STEREO A EUVI 195 imagery. The outlook for X-ray activity is therefore tentatively a slight decrease as AR3296 departs further westwards.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: X-ray flux plots at GEO from GOES over past 24 hours with occasional C-class flares.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16 has remained at its resting Background through this 24-hour period. The most likely source for generating S1 events (AR3296) is now occupying the most reliably-connecting sector of the Sun (with Earth), should a suitable flare and solar radiation storm arise. The risk should very gradually ease into the new UTC working week as this spot group rotates from this potent position.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	1
Very Active	≥ S3 *	No	1	1	1	1

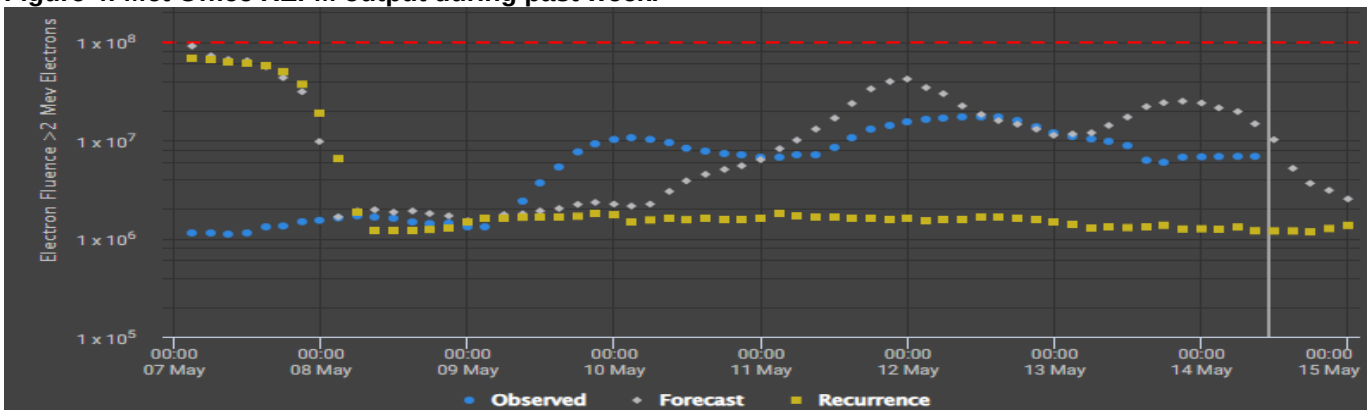
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has ranged from Moderate to Normal Background levels over the past 24 hours, as in the previous UTC day, implying a steady state has been reached. With very little on the disc likely to cause a significant solar wind speed enhancements (the tenuous unnumbered coronal hole included), electron flux and fluence ought to remain below Active throughout, with increasing uncertainty later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Met Office REFM output during past week.



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